PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-201134

(43)Date of publication of application : 18.07.2000

(51)Int.Cl. H04J 13/04
H04J 1/00
H04J 11/00
H04L 27/34

(21)Application number : 11-001205

(22)Date of filing : 06.01.1999

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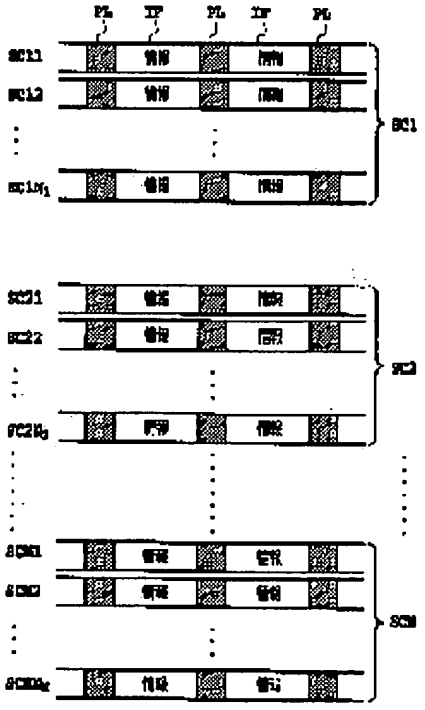
ADACHI FUMIYUKI

(54) METHOD FOR TRANSMITTING MULTI-CARRIER/DS-CDMA AND DEMODULATION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To execute efficient channel estimation and compensation by equalizing variation in the transmission lines of respective subcarriers by using a DS system in a multi-carrier/DS-CDMA system.

SOLUTION: In the method for extending the band of an information symbol by a high speed diffusion code series and transmitting the band-extended diffusion signal by plural subcarriers having a frequency interval corresponding to n times (n: a natural number) the updating frequency of the diffusion code series, plural channels are allocated to each of plural subcarriers, and plural pilot symbols are inserted into the information symbol series in each communication channel in a time-wisely multiplexed state to transmit the diffusion signal.



LEGAL STATUS

[Date of request for examination]	18.01.2002
[Date of sending the examiner's decision of rejection]	01.08.2003
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
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[Date of registration]	
[Number of appeal against examiner's decision of rejection]	2003-16885
[Date of requesting appeal against examiner's decision of rejection]	01.09.2003
[Date of extinction of right]	

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a channel configuration Fig. corresponding to claim 1.
[Drawing 2] It is a channel configuration Fig. corresponding to claim 1.
[Drawing 3] It is a channel configuration Fig. corresponding to claim 1.
[Drawing 4] It is a channel configuration Fig. explaining the conventional pilot symbol insertion.
[Drawing 5] It is a channel configuration Fig. corresponding to claim 2.
[Drawing 6] It is a channel configuration Fig. corresponding to claim 3.
[Drawing 7] It is a channel configuration Fig. corresponding to claim 4.
[Drawing 8] It is a channel configuration Fig. corresponding to claim 5.
[Drawing 9] It is a channel configuration Fig. corresponding to claim 6.
[Drawing 10] It is the block diagram showing an example of the multi-carrier / DS-CDMA demodulator of this invention corresponding to claim 7.
[Drawing 11] It is the block diagram showing an example of the multi-carrier / DS-CDMA demodulator of this invention corresponding to claim 8.
[Drawing 12] It is the block diagram showing an example of the multi-carrier / DS-CDMA demodulator of this invention corresponding to claim 9.
[Drawing 13] It is the block diagram showing an example of the multi-carrier / DS-CDMA demodulator of this invention corresponding to claim 10.
[Drawing 14] It is the block diagram showing an example of the multi-carrier / DS-CDMA demodulator of this invention corresponding to claim 11.
[Drawing 15] It is the block diagram showing an example of the multi-carrier / DS-CDMA demodulator of this invention corresponding to claim 12.
[Drawing 16] It is the explanatory view of the example 1 of the multi-carrier / DS-CDMA channel presumption of this invention.
[Drawing 17] It is the explanatory view of the example 2 of the multi-carrier / DS-CDMA channel presumption of this invention.
[Drawing 18] It is the explanatory view of the example 3 of the multi-carrier / DS-CDMA channel presumption of this invention.
[Drawing 19] It is the explanatory view of the example 4 of the multi-carrier / DS-CDMA channel presumption of this invention.
[Drawing 20] It is the explanatory view of the example 5 of the multi-carrier / DS-CDMA channel presumption of this invention.
[Drawing 21] It is the explanatory view of the example 6 of the multi-carrier / DS-CDMA channel presumption of this invention.
[Drawing 22]

* NOTICES *

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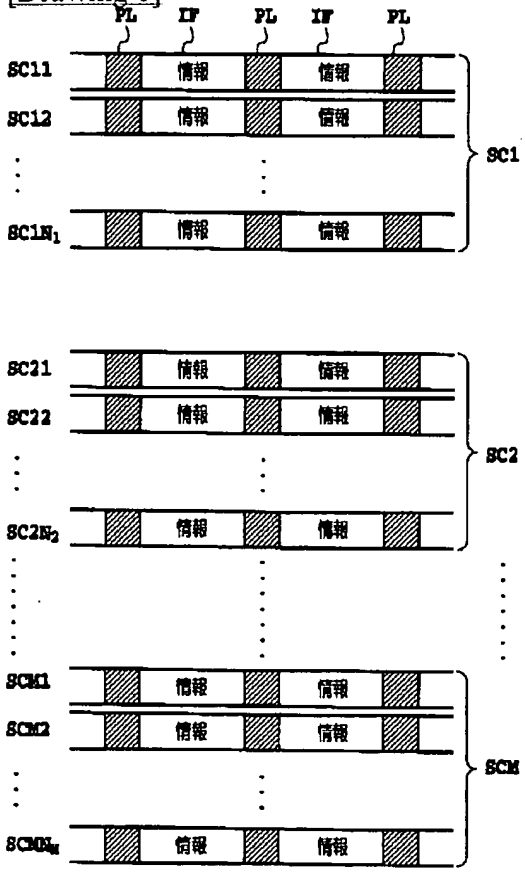
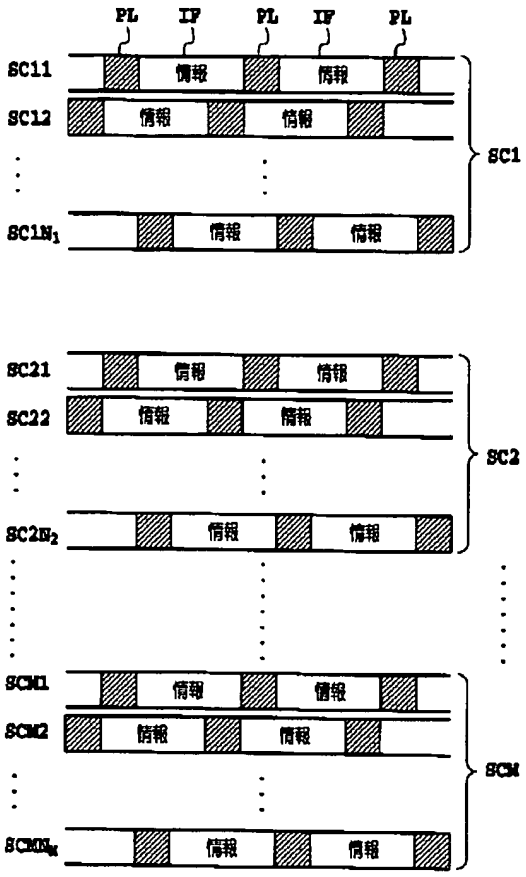
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]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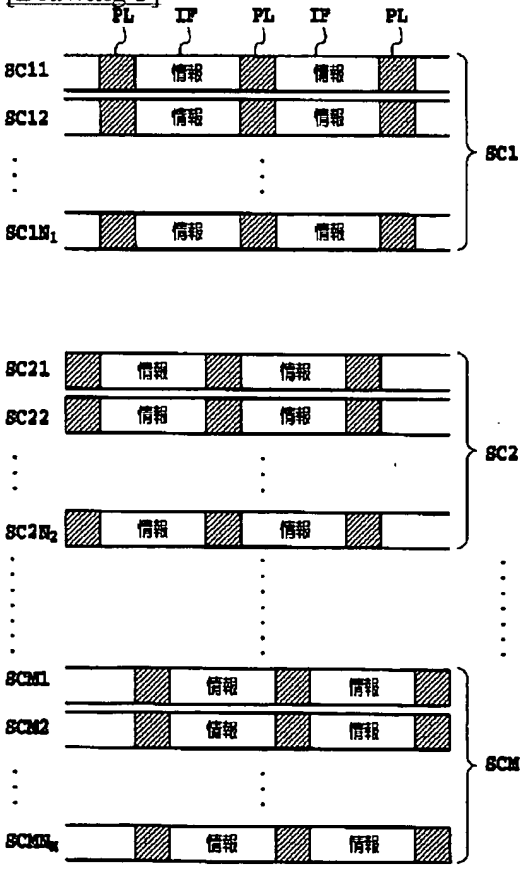
IF
PL
IF
PL
SC11
SC12
SC1N1
SC1
SC21
SC22
SC2N2
SC2
SCM1
SCM2
SCMNM
SCM
情報

[Drawing 3]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IF
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IF
PL
SC11
SC12
SC1N1
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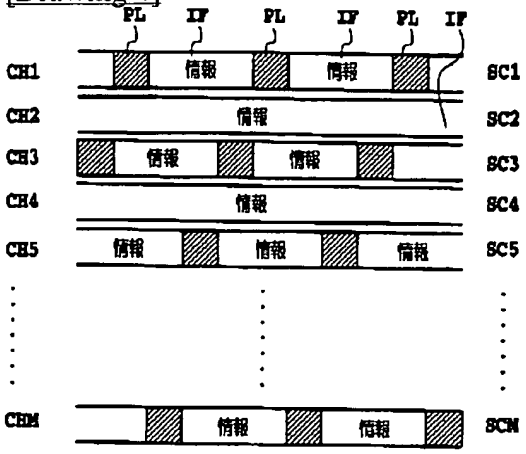
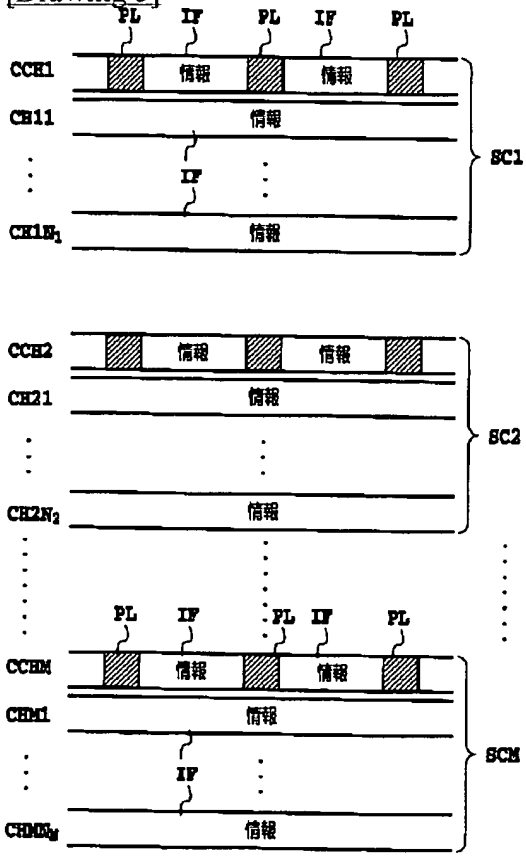
SCM
情報

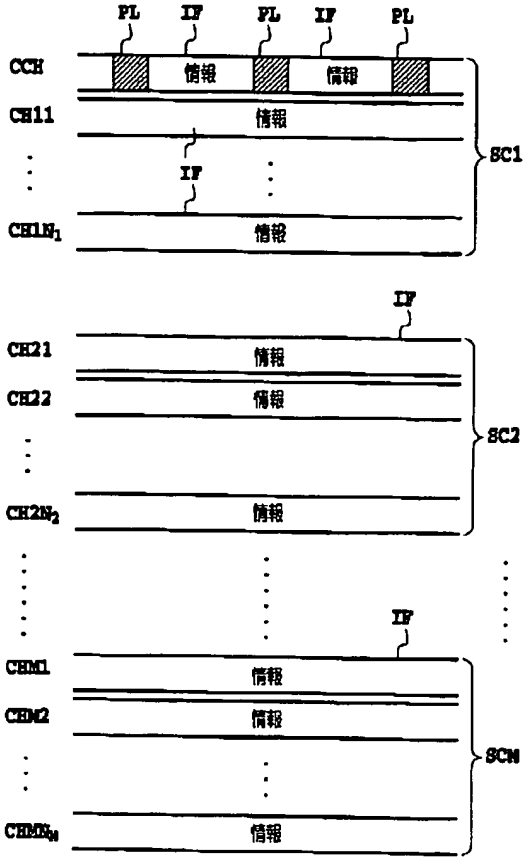
[Drawing 4]



[Drawing 5]



[Drawing 6]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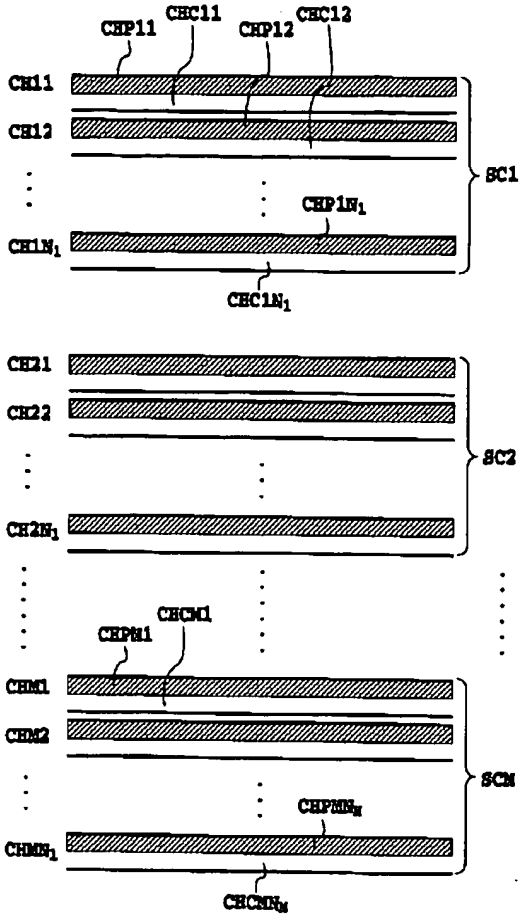
IF
PL
IF
PL
CCH
情報
情報
CH11
情報
IF
CH1N1
情報
SC1
IF
CH21
情報
CH22
情報
SC2
CH2N2
情報
IF
CHM1
情報
CHM2
情報
SCM
CHMNM
情報

[Drawing 7]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CHM2
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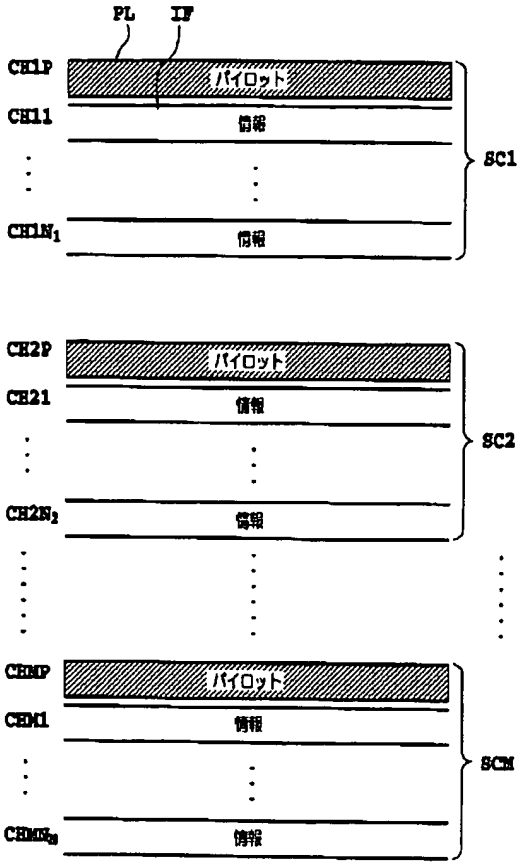
CHPMNM
CHMN1
CHCMNM

[Drawing 8]


PL
IF
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CH11
情報
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情報
SC1
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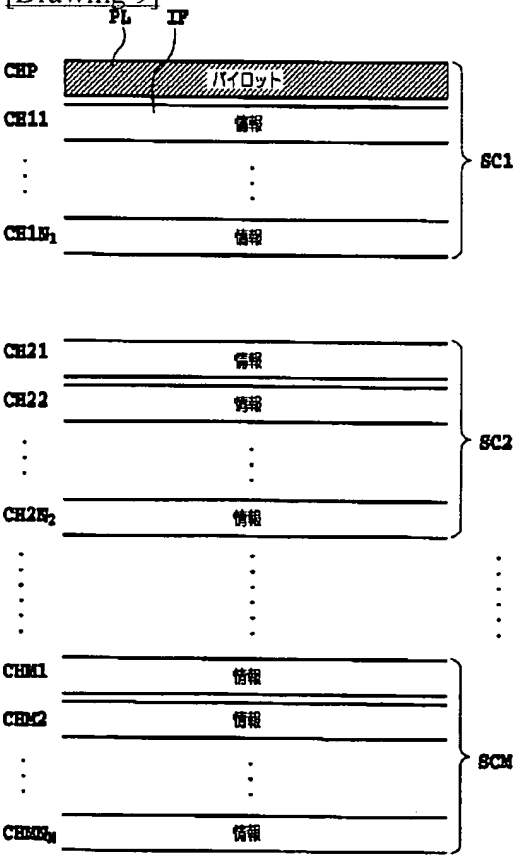
情報
CHMNM
情報
SCM

[Drawing 9]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SCM

[Drawing 10]

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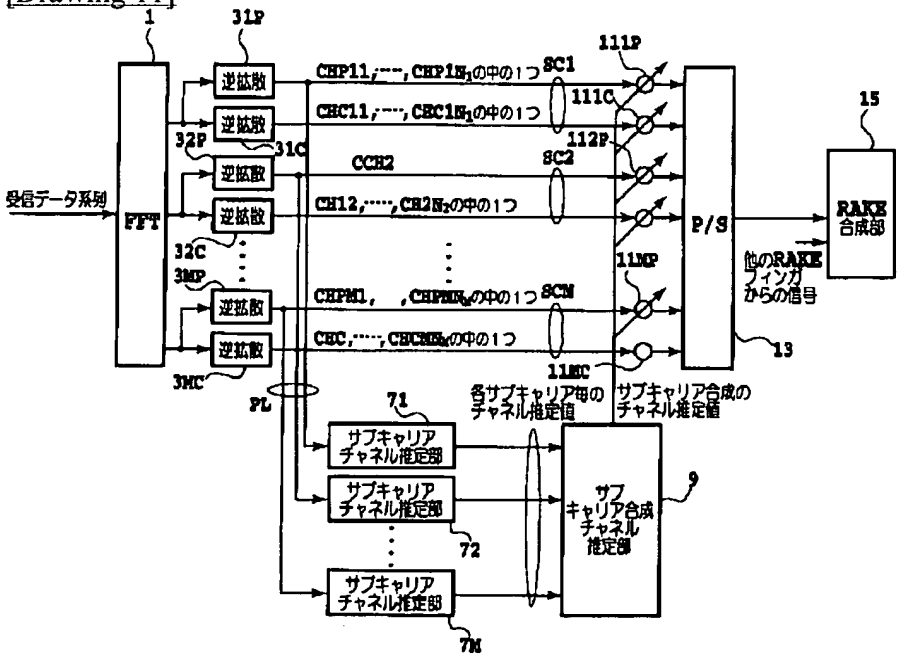
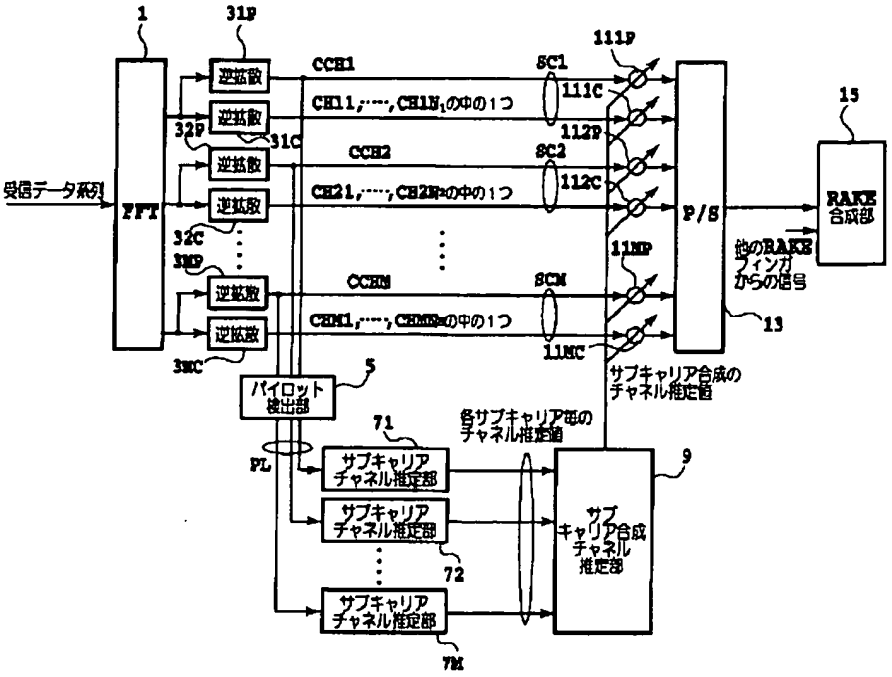
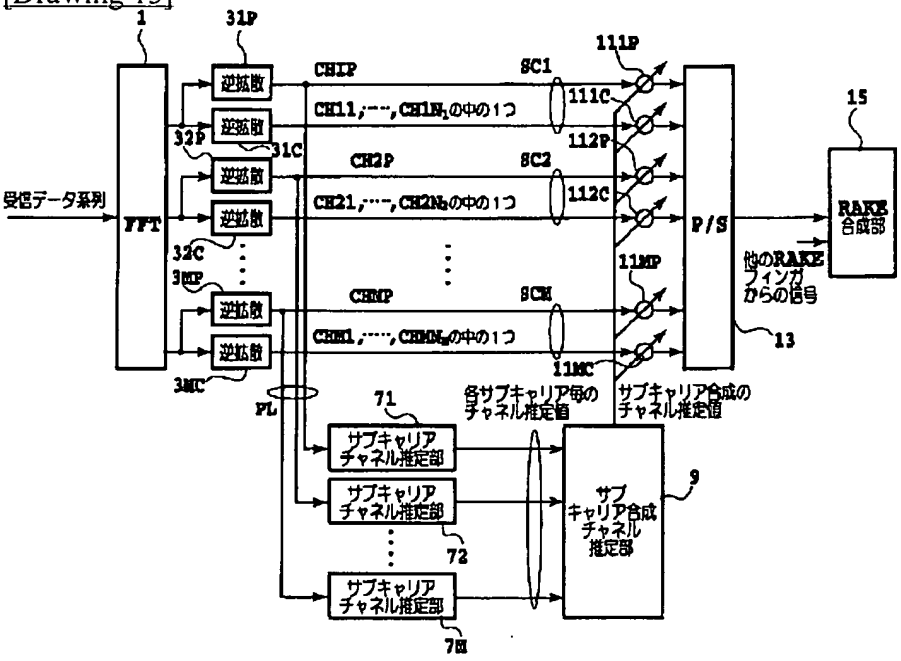
[Drawing 11]



[Drawing 12]



[Drawing 13]



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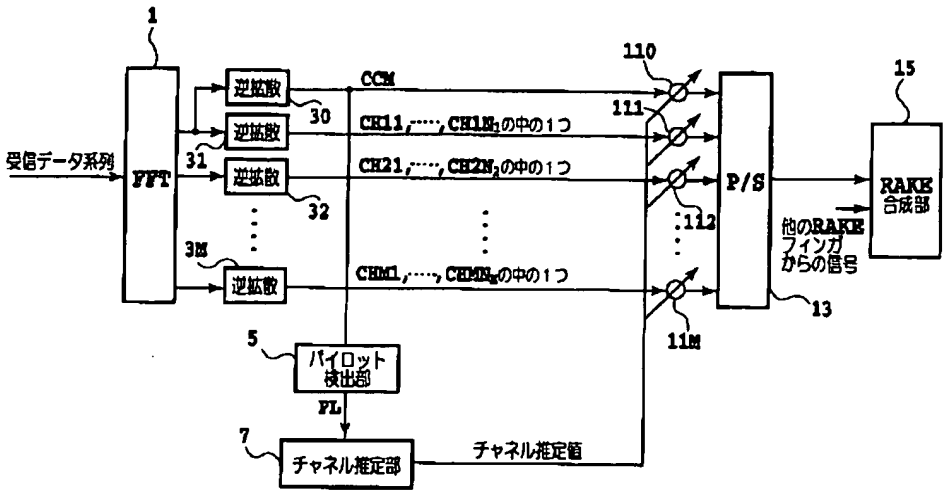
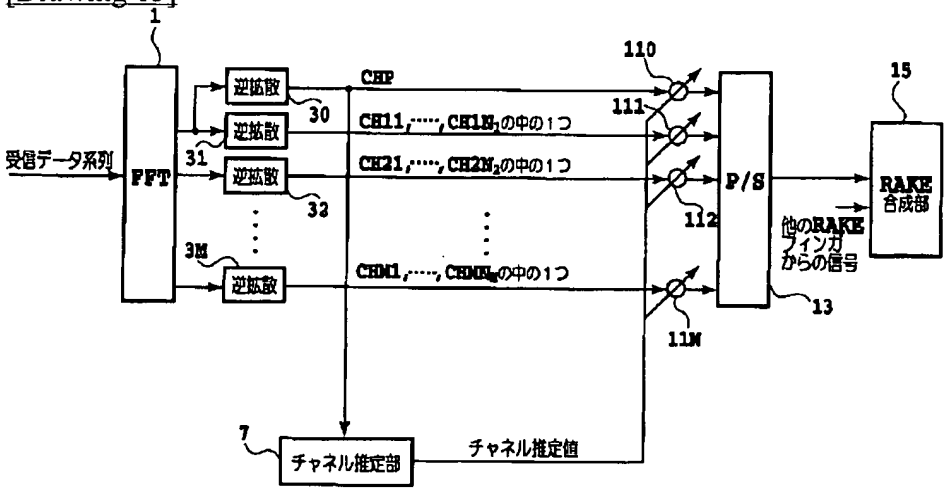
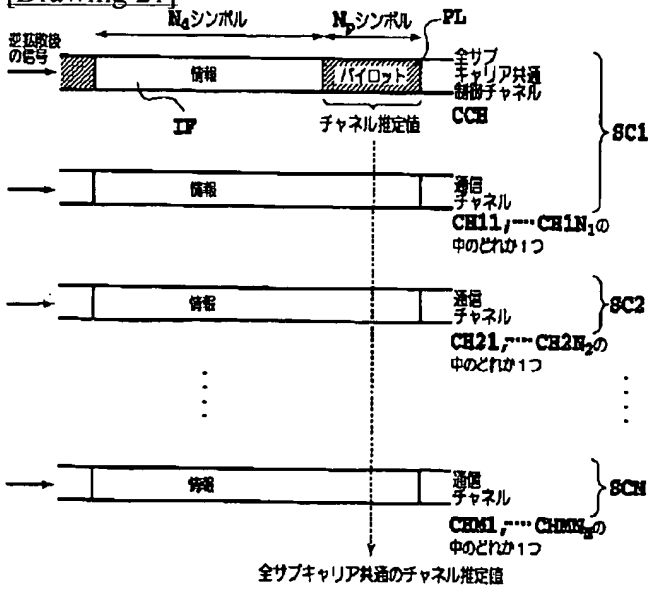


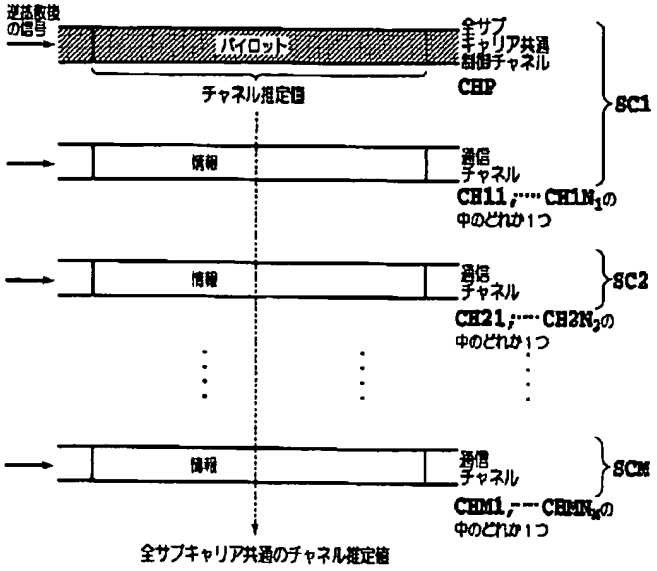
[Drawing 15]



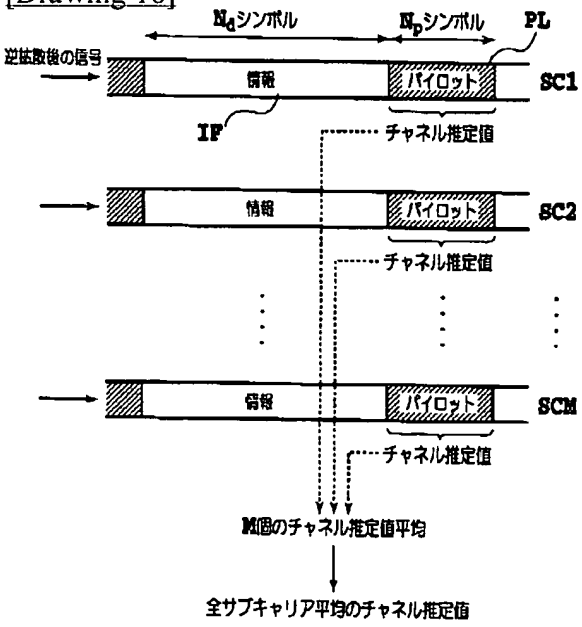
[Drawing 21]



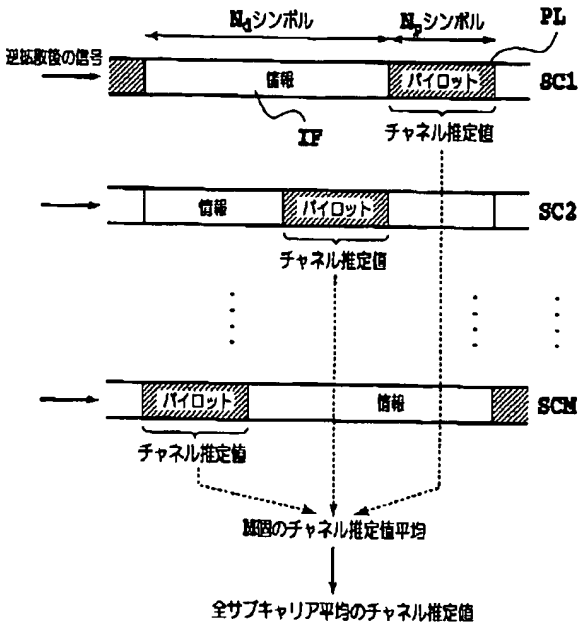
[Drawing 22]



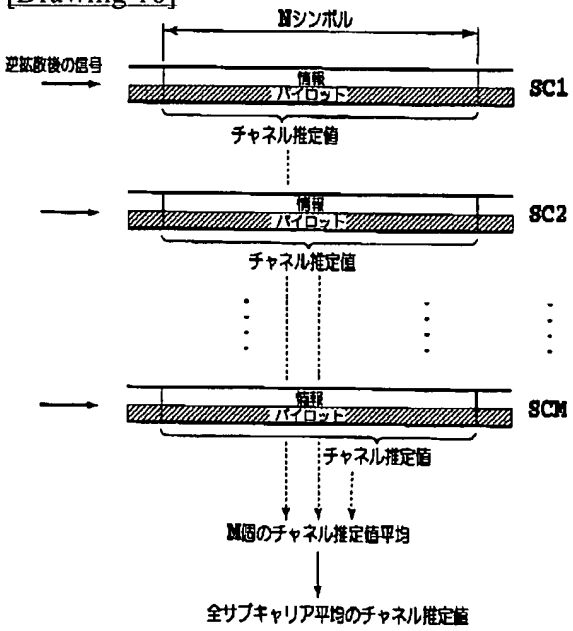
[Drawing 16]



[Drawing 17]



[Drawing 18]



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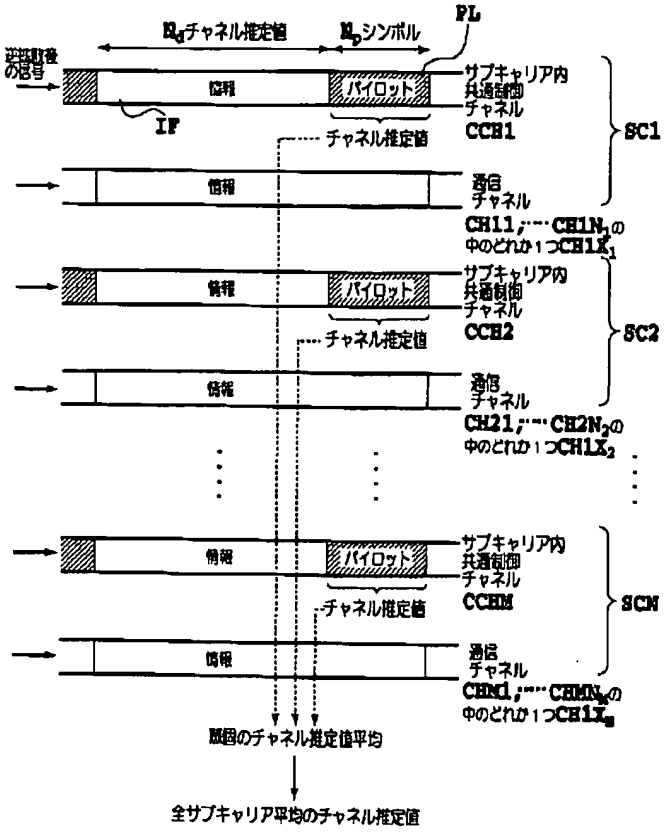
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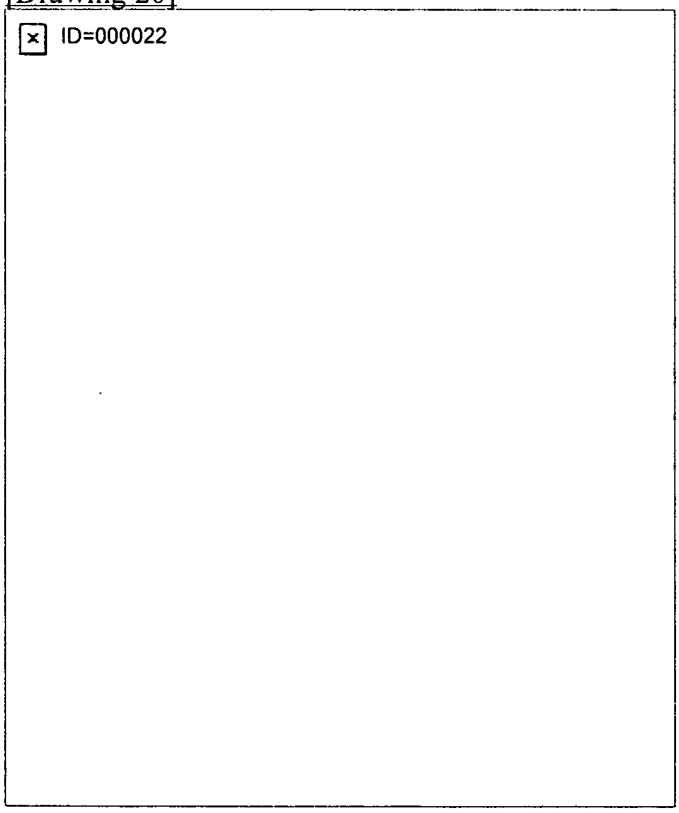
N_dチャネル推定値
N_pシンボル
情報
パイロット
IF
サブキャリア内共通制御チャネル
CCH1
チャネル推定値
通信チャネル
CH11,…CH1N_1の中のどれか1つCH1X_1
SC1
CCH2
CH21,…CH2N_2の中のどれか1つCH1X_2
SC2
CCHM
CHM1,…CHMN_Mの中のどれか1つCH1X_M
SCM
同図のチャネル推定値平均
全サブキャリア平均のチャネル推定値

[Drawing 20]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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the multi-carrier / the DS-CDMA transmission approach, and demodulator which perform high-speed transmission in the multi-pass phasing environment of mobile communication.
[0002]
[Description of the Prior Art] In the bottom of migration communication environment, amplitude fluctuation and phase fluctuation of the communication channel resulting from the Rayleigh fading accompanying fluctuation of the relative position of a mobile station and a base station arise. Therefore, it is necessary to identify the phase of an input signal by the absolute phase for every information symbol with the phase modulation system which transmits information with a subcarrier phase.
[0003] the pilot signal insertion method (Yamashita --) of the multi-carrier modulation technique which used "16QAM 1 examination (Yamashita --) of the adaptive equalization method of OFDM by Hara, the Morinaga:Institute of Electronics, Information and Communication Engineers spring convention, B-356, and the pp.2 March, 1994 [-356 or]" "pilot symbol Kuwahara, Itami, Ito : in the Institute of Electronics, Information and Communication Engineers synthesis convention, B-5-245, and pp. September, 1998 [609 or] Phasing distortion is presumed to an above-mentioned problem using the pilot symbol of phase known which are two or more suitable subcarrier spacing among all subcarriers, and was inserted the fixed period between information symbols, and the method of compensating the distortion is proposed.
[0004] An example of the insertion approach of the pilot symbol in this case is shown in drawing 4 . In these approaches, the pilot symbol PL is inserted in each of the subcarriers SC1, --, SCM of plurality (M pieces) assigned to each of the communication channels CH1, --, CHM of plurality (M pieces) a fixed period. By measuring each user's amplitude and phase of an input signal of each pass in these pilot symbol PL, and interpolating those measured value in the direction of time amount, and the direction of a subcarrier two-dimensional, transmission-line fluctuation of the information symbol IF is presumed, and the fluctuation is compensated.
[0005] By these approaches, transmission-line fluctuation of the subcarrier in which the pilot symbol is not inserted by using interpolation without inserting a pilot symbol in all the M subcarriers, when the transmission-line fluctuation for every subcarrier has correlation is presumed.
[0006] However, if an information transmission rate becomes a high speed and an occupancy frequency band becomes large, since correlation of the transmission-line fluctuation between each subcarrier will become small under the effect of a delay wave (echo), it is necessary to insert a pilot symbol in each of M subcarriers.
[0007] When a signal-to-noise power ratio (SNR) is small, in order to perform advanced presumption to transmission-line fluctuation, as shown in drawing 4, many pilot symbols PL needed to be added to each of each M subcarrier.
[0008] On the other hand, in a multi-carrier / DS-CDMA method, transmission-line fluctuation in each

subcarrier can be made equal by separating a delay wave using DS method. However, in the conventional multi-carrier / DS-CDMA method, the method of performing discernment of information data and a judgment was common by performing differential coding which carries and transmits information to the relative topology of the symbol of order for every subcarrier by the transmitting side, and performing differentially coherent detection for every subcarrier by the receiving side.
[0009]
[Problem(s) to be Solved by the Invention] However, in the conventional example of above-mentioned multi-carrier / DS-CDMA method, in order to carry out differential coding of the transmit data, the 1-bit error in the wireless section turns into a 2-bit error of information data. Therefore, in 2 phase PE (BPSK modulation), 3dB of receiving error rates deteriorates in the same signal power pair noise power ratio (SNR) [a synchronous detection].
[0010] Then, this invention aims at performing efficient channel presumption and compensation in a multi-carrier / DS-CDMA method by making equal transmission-line fluctuation in each subcarrier using DS method.
[0011]
[Means for Solving the Problem] Invention according to claim 1 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. In the approach of transmitting this diffusion signal by which band expansion was carried out by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating It is characterized by carrying out time multipled of two or more pilot symbols to said two or more subcarriers of each, inserting two or more communication channels in them between the sequences of an information symbol, in each of allocation and said communication channel, and transmitting said diffusion signal.
[0012] Invention according to claim 2 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. In the approach of transmitting this diffusion signal by which band expansion was carried out by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating It is characterized by preparing a common control channel in each of two or more of said subcarriers, carrying out time multipled of two or more pilot symbols, inserting them between the sequences of an information symbol, in this common control channel, and transmitting said diffusion signal.
[0013] Invention according to claim 3 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. In the approach of transmitting this diffusion signal by which band expansion was carried out by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating To k subcarriers (k: natural number, number of k< subcarrier) among said two or more subcarriers It is characterized by carrying out time multipled of two or more pilot symbols, inserting k control channels common to all subcarriers between the sequences of an information symbol, in allocation and this control channel, and transmitting said diffusion signal.
[0014] Invention according to claim 4 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. In the approach of transmitting this diffusion signal by which band expansion was carried out by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating It is characterized by carrying out sign multiplex [of the pilot channel which consists of a communication channel to which each of allocation and two or more of these channels transmits information data, and a pilot symbol in two or more channels] to each of two or more of said subcarriers, and transmitting said diffusion signal.
[0015] Invention according to claim 5 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. In the approach of transmitting this diffusion signal by which band expansion was carried out by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating It is characterized by assigning two or more communication channels which transmit information data, and a common [in

a subcarrier] pilot channel to each of two or more of said subcarriers, and transmitting said diffusion signal to it.

[0016] Invention according to claim 6 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. In the approach of transmitting this diffusion signal by which band expansion was carried out by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating To k subcarriers (k: natural number, number of k< subcarrier) in said two or more subcarriers It is characterized by assigning k common pilot channels to the communication channel which transmits information data for channels other than said pilot channel among allocation and said k subcarriers to all subcarriers, and transmitting said diffusion signal.

[0017] Invention according to claim 7 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. This diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating. In each of allocation and said communication channel, carry out time multipled of two or more pilot symbols to said two or more subcarriers of each, insert two or more communication channels in them between the sequences of an information symbol, and said diffusion signal is transmitted. The means which carries out the back diffusion of electrons of the diffusion signal which is the demodulator which receives the diffusion signal and restores to an information symbol, and was received, From the output of said back-diffusion-of-electrons means, the pilot symbol to which time multipled of the individual exception in the communication channel in each of said subcarrier was carried out is equalized. A subcarrier channel presumption means to calculate the channel estimate about each subcarrier, The channel estimate about each subcarrier called for by said subcarrier channel presumption means is compounded over all subcarriers. A subcarrier composition channel presumption means to calculate the channel estimate of subcarrier composition, The channel estimate of the subcarrier composition for which it asked with said subcarrier composition channel presumption means, and the output of said back-diffusion-of-electrons means are inputted. It is characterized by having a channel fluctuation compensation means to compensate channel fluctuation of the communication channel in each of said subcarrier based on the channel estimate of the subcarrier composition concerned.

[0018] Invention according to claim 8 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. This diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating. Two or more channels to said two or more subcarriers of each each of allocation and this multiple channel Carry out sign multiplex [of the communication channel which transmits information data, and the pilot channel which consists of pilot symbols], and said diffusion signal is transmitted. The means which carries out the back diffusion of electrons of the diffusion signal which is the demodulator which receives the diffusion signal and restores to an information symbol, and was received, From the output of said back-diffusion-of-electrons means, the pilot symbol to which sign multiplex [of the individual exception in the channel in each of said subcarrier] was carried out is equalized. A subcarrier channel presumption means to calculate the channel estimate about each subcarrier, The channel estimate about each subcarrier called for by said subcarrier channel presumption means is compounded over all subcarriers. A subcarrier composition channel presumption means to calculate the channel estimate of subcarrier composition, The channel estimate of the subcarrier composition for which it asked with said subcarrier composition channel presumption means, and the output of said back-diffusion-of-electrons means are inputted. It is characterized by having a channel fluctuation compensation means to compensate channel fluctuation of the communication channel in each of said subcarrier based on the channel estimate of the subcarrier composition concerned.

[0019] Invention according to claim 9 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. This diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence

n times (n: natural number) the frequency spacing of updating. Prepare a common control channel in each of two or more of said subcarriers, in this common control channel, carry out time multipled of two or more pilot symbols, insert them between the sequences of an information symbol, and said diffusion signal is transmitted. The means which carries out the back diffusion of electrons of the diffusion signal which is the demodulator which receives the diffusion signal and restores to an information symbol, and was received, From the output of said back-diffusion-of-electrons means, the pilot symbol in a common control channel by which time multipled was carried out is equalized to each of said subcarrier. A subcarrier channel presumption means to calculate the channel estimate about each subcarrier, The channel estimate about each subcarrier called for by said subcarrier channel presumption means is compounded over all subcarriers. A subcarrier composition channel presumption means to calculate the channel estimate of subcarrier composition, The channel estimate of the subcarrier composition for which it asked with said subcarrier composition channel presumption means, and the output of said back-diffusion-of-electrons means are inputted. It is characterized by having a channel fluctuation compensation means to compensate channel fluctuation of the communication channel in each of said subcarrier based on the channel estimate of the subcarrier composition concerned.

[0020] Invention according to claim 10 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. This diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers which have the frequency of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating. Assign two or more communication channels which transmit information data to each of two or more of said subcarriers, and a common [in a subcarrier] pilot channel, and said diffusion signal is transmitted. The means which carries out the back diffusion of electrons of the diffusion signal which is the demodulator which receives the diffusion signal and restores to an information symbol, and was received, From the output of said back-diffusion-of-electrons means, the pilot symbol of a common pilot channel is equalized to each of said subcarrier. A subcarrier channel presumption means to calculate the channel estimate about each subcarrier, The channel estimate about each subcarrier called for by said subcarrier channel presumption means is compounded over all subcarriers. A subcarrier composition channel presumption means to calculate the channel estimate of subcarrier composition, The channel estimate of the subcarrier composition for which it asked with said subcarrier composition channel presumption means, and the output of said back-diffusion-of-electrons means are inputted. It is characterized by having a channel fluctuation compensation means to compensate channel fluctuation of the communication channel in each of said subcarrier based on the channel estimate of the subcarrier composition concerned.

[0021] Invention according to claim 11 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. This diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers which have the frequency of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating. To k subcarriers (k: natural number, number of k< subcarrier) among said two or more subcarriers In allocation and this control channel, carry out time multipled of two or more pilot symbols, insert k control channels common to all subcarriers between the sequences of an information symbol, and said diffusion signal is transmitted. The means which carries out the back diffusion of electrons of the diffusion signal which is the demodulator which receives the diffusion signal and restores to an information symbol, and was received, A channel presumption means to compound the pilot symbol in k common control channels by which time multipled was carried out to said all subcarriers, and to calculate each channel estimate for subcarriers from the output of said back-diffusion-of-electrons means, Each channel estimate for subcarriers calculated with said channel presumption means and the output of said back-diffusion-of-electrons means are inputted. It is characterized by having a channel fluctuation compensation means to compensate channel fluctuation of the communication channel in each of said subcarrier based on the channel estimate concerned.

[0022] Invention according to claim 12 carries out band expansion of the information symbol by the high-speed diffusion sign sequence. This diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating. To k subcarriers (k: natural number,

number of k< subcarrier) among said two or more subcarriers Assign k control channels common to all subcarriers to allocation and the communication channel which transmits information data for channels other than said pilot channel among said k subcarriers, and said diffusion signal is transmitted. The means which carries out the back diffusion of electrons of the diffusion signal which is the demodulator which receives the diffusion signal and restores to an information symbol, and was received, A channel presumption means to compound the pilot symbol of k common pilot channels to said all subcarriers, and to calculate each channel estimate for subcarriers from the output of said back-diffusion-of-electrons means, Each channel estimate for subcarriers calculated with said channel presumption means and the output of said back-diffusion-of-electrons means are inputted. It is characterized by having a channel fluctuation compensation means to compensate channel fluctuation of the communication channel in each of said subcarrier based on the channel estimate concerned.

[0023]

[Function] If an information transmission rate becomes a high speed and correlation of the transmission-line fluctuation between each subcarrier becomes small by the conventional multi-carrier method, by this invention, the insertion approach of a pilot symbol will not be limited to having had to insert many pilot symbols for every subcarrier. And in this invention, since all the inserted pilot symbols can be used for channel presumption and compensation of all subcarriers, channel presumption and compensation are efficiently realizable for high degree of accuracy more.

[0024] Drawing 1 , drawing 2 , and drawing 3 show an example of the channel configuration by this invention corresponding to claim 1. Here, the axis of abscissa of each channel shows time amount, and the axis of ordinate shows power. Band expansion of the information symbol is carried out by the high-speed diffusion sign sequence, and this diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers SC1, --, SCM which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating.

[0025] Communication channel SC11 of plurality [subcarriers / SC1, --, SCM / of plurality (M pieces)], --, SC1N1 ; --;SCM1, --, SCMNM It assigns, respectively. In each communication channel of each subcarrier, it transmits by carrying out time multipled of two or more pilot symbols PL, and inserting them between the sequences of the information symbol IF.

[0026] All the subcarriers SC1, --, SCM are covered, and drawing 1 is all communication channel SCs11, --, SCMNM. The channel configuration at the time of inserting the pilot symbol PL to the same timing is shown. Drawing 2 shows each subcarrier SC 1, --, a channel configuration when the timing of each pilot symbol PL in SCM differs. Drawing 3 is all communication channel SCs11, --, SC1N1 within each subcarrier SC 1, --, SCM. ; --;SCM1, --, SCMNM The channel configuration when the pilot symbol PL is inserted to the same timing and the timing of the pilot symbol PL differs between subcarriers is shown.

[0027] Drawing 5 shows an example of the channel configuration of this invention corresponding to claim 2. Here, the axis of abscissa of each channel shows time amount, and the axis of ordinate shows power.

[0028] Band expansion of the information symbol is carried out by the high-speed diffusion sign sequence, and this diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers SC1, --, SCM which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating.

[0029] Communication channel SC11 of common control channel CCH1 in a subcarrier, --, CCHM, and plurality, --, SC1N1; --;SCM1, --, SCMNM It assigns, respectively. [subcarriers / SC1, --, SCM / of plurality (M pieces)] Between information symbol IF sequences, each common control channel in a subcarrier addressed to each subcarrier carries out time multipled of two or more pilot symbols PL, inserts them, and is transmitted. In drawing 5 , although the channel configuration at the time of inserting each common control channel CCH1 in a subcarrier, --, the pilot symbol PL in CCHM to the same timing over all the subcarriers SC1, --, SCM is shown, each common control channel CCH1 in a subcarrier, --, the pilot symbol PL in CCHM can also be inserted to different timing for every subcarrier.

[0030] Drawing 6 shows an example of the channel configuration of this invention corresponding to claim 3. Here, the axis of abscissa of each channel shows time amount, and the axis of ordinate shows power.
[0031] Band expansion of the information symbol is carried out by the high-speed diffusion sign sequence, and this diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers SC1, --, SCM which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating.
[0032] k common control channel CCHs are assigned to k subcarriers (k: natural number, k<M) to all subcarriers among the subcarriers SC1, --, SCM of plurality (M pieces). Drawing 6 shows the case of k= 1 and is assigning common control channel CCH to the subcarrier SC 1. In common control channel CCH, it transmits by carrying out time multipled of two or more pilot symbols PL, and inserting them between information symbol IF sequences.
[0033] Drawing 7 shows an example of the channel configuration of this invention corresponding to claim 4. Here, the axis of abscissa of each channel shows time amount, and the axis of ordinate shows power.
[0034] Band expansion of the information symbol is carried out by the high-speed diffusion sign sequence, and this diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers SC1, --, SCM which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating.
[0035] The channel CH11 of plurality [each / of the subcarriers SC1, --, SCM of plurality (M pieces)], --, CH1N1 ; --;CHM1, --, CHMNM It assigns. The communication channel CHC11 and -- which transmit information data in each channel, CHC1N1 ; --;CHCM1, --, CHCMNM The pilot channel CHP11 which consisted of pilot symbols, --, CHP1N1 ; -- It transmits by carrying out sign multiplex [of;CHPM1, --, the CHPMNM].
[0036] Drawing 8 shows an example of the channel configuration by this invention corresponding to claim 5. Here, the axis of abscissa of each channel shows time amount, and the axis of ordinate shows power.
[0037] Band expansion of the information symbol is carried out by the high-speed diffusion sign sequence, and this diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers SC1, --, SCM which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating.
[0038] Two or more communication channels CH11 and -- which store the information data IF in each of the subcarriers SC1, --, SCM of plurality (M pieces), CH1N1 ; --;CHM1, --, CHMNM Community pilot channel CH1P, --, CHMP are assigned in the subcarrier which consists of pilot symbols PL, respectively.
[0039] Drawing 9 shows an example of the channel configuration by this invention corresponding to claim 6. The axis of abscissa of each channel shows time amount, and the axis of ordinate shows power here.
[0040] Band expansion of the information symbol is carried out by the high-speed diffusion sign sequence, and this diffusion signal by which band expansion was carried out is transmitted by two or more subcarriers SC1, --, SCM which have the frequency (chip rate) of a diffusion sign sequence n times (n: natural number) the frequency spacing of updating.
[0041] Two or more communication channels CH11 and -- which transmit the information data IF to each of the subcarriers SC1, --, SCM of plurality (M pieces), CH1N1 ; --;CHM1, --, CHMNM It assigns. k common pilot channels CHP are assigned to k subcarriers (k: natural number, k<M) to all subcarriers. In drawing 9 R> 9, the case of k= 1 is shown and the common pilot channel CHP is assigned to the subcarrier SC 1. Channels other than the pilot channel CHP are assigned to the communication channel which transmits information data among k subcarriers.
[0042] Drawing 10 and drawing 11 show the multi-carrier / DS-CDMA demodulator of this invention corresponding to claims 7 and 8, respectively. Drawing 10 shows the demodulator at the time of using a channel configuration (referring to drawing 1 - drawing 3) as shown in claim 1. Drawing 11 shows the

demodulator at the time of using a channel configuration (referring to drawing 7) as shown in claim 4.
[0043] In drawing 10 , the conversion means 1, such as FFT (Fast Fourier Transform fast Fourier transform) and DFT (Discrete Fourier Transform discrete Fourier transform), decompose a received-data sequence into the component to each subcarriers SC1, --, SCM. Here, the example which used FFT is shown. The sequence over each decomposed subcarrier is supplied to the back-diffusion-of-electrons means 31, --, 3M, and using the diffusion sign replica according to the receiving timing of each multi-pass, the back diffusion of electrons is carried out and it takes out here.
[0044] as shown in drawing 1 - drawing 3 , when time multipled of the pilot symbol is carried out to the information sequence, the location of the pilot symbol contained in the sequence over each subcarrier after the back diffusion of electrons by the pilot detecting element 5 is detected, and the pilot symbol PL of the sequence of M individual is taken out. The receiving channel in two or more pilot symbols PL contained in each subcarriers SC1, --, SCM by the subcarrier channel presumption sections 71, --, 7M is equalized using the detected pilot symbol PL, and the channel estimate to each subcarrier is calculated.
[0045] The channel estimate to each subcarrier for which it asked is supplied to the subcarrier composition channel presumption section 9, it compounds by equalization, linear interpolation processing, etc. over all subcarriers, and the channel estimate of subcarrier composition is calculated. Here, the equalized example is shown. The multiplication of the complex-conjugate value of this channel estimate and the data from the back-diffusion-of-electrons means 31, --, 3M is carried out with Multipliers 111, --, 11M, respectively, and phasing phase fluctuation of each information symbol is compensated. The signal after phase fluctuation compensation is supplied to the parallel serial conversion machine 13, and it changes into serial data. With the signal from other RAKE fingers, this serial data is supplied to the RAKE composition section 15, and inphase composition is carried out.
[0046] In drawing 11 , the conversion means 1, such as FFT and DFT, decompose a received-data sequence into the component to each subcarriers SC1, --, SCM. Here, the example which used FFT is shown. They are the back-diffusion-of-electrons means 31P and 31C about the sequence over each decomposed subcarrier.; -- The pilot channel CHP 1x1 which supplies;3MP and 3MC and is contained in each sequence here, --, CHPMxM (here) The natural number and the communication channel CHC 1x1 of x1, --, CHPMxM 1 - N1 It is x1 <=N1 at any inner one. The natural number and xM 1-NM It is xM <=NM at any inner one (it is here). x1 1 - N1 It is x1 <=N1 at any inner one. The natural number and xM 1-NM It is xM <=NM at any inner one. Natural number (x1 and xM shall be defined similarly hereafter) Using the diffusion sign replica according to the receiving timing of each multi-pass, the back diffusion of electrons is carried out and it takes out.
[0047] The sequence of the pilot channel by which the back diffusion of electrons was carried out is inputted into the channel presumption sections 71, --, 7M addressed to each subcarrier, the receiving channel in two or more pilot symbols PL contained in each subcarriers SC1, --, SCM is equalized, and the channel estimate to each subcarrier is calculated.
[0048] The channel estimate for every subcarrier for which it asked is supplied to the subcarrier composition channel presumption section 9, it compounds by equalization, linear interpolation processing, etc. over all subcarriers, and the channel estimate of subcarrier composition is calculated. Here, the equalized example is shown. The complex-conjugate value and the back-diffusion-of-electrons means 31P and 31C of this channel estimate; -- They are Multipliers 111P and 111C about the data from;3MP and 3MC.; -- By;11MP and 11MC, multiplication is carried out and phasing phase fluctuation of each information symbol is compensated, respectively. The signal after phase fluctuation compensation is supplied to the parallel serial conversion machine 13, and it changes into serial data. This serial data is supplied to the RAKE composition section 15 with the signal from other RAKE fingers, and inphase composition is carried out.
[0049] Drawing 12 and drawing 13 show the multi-carrier / DS-CDMA demodulator of this invention corresponding to claims 9 and 10, respectively. Drawing 12 shows the demodulator at the time of using a channel configuration (referring to drawing 5) as shown in claim 2. Drawing 13 shows the demodulator at the time of using a channel configuration (referring to drawing 8) as shown in claim 5.
[0050] In drawing 12 , conversion means, such as FFT and DFT, decompose a received-data sequence

into the component to each subcarriers SC1, --, SCM. Here, the example which used FFT is shown. They are the back-diffusion-of-electrons means 31P and 31C about the sequence for every decomposed subcarrier.; -- Common control channel CCH1 in a subcarrier and -- which supply;3MP and 3MC and are contained in each sequence here, CCHM and the communication channel CH to restore 1x1, --, CHMxM Using the diffusion sign replica according to the receiving timing of each multi-pass, the back diffusion of electrons is carried out and it takes out.

[0051] the pilot detecting element 5 detects the location of common control channel CCH1 in a subcarrier after the back diffusion of electrons, --, the pilot symbol contained in CCHM, and the pilot symbol PL of the sequence of M individual is taken out. The receiving channel in two or more pilot symbols PL contained in each subcarriers SC1, --, SCM by the subcarrier channel presumption sections 71, --, 7M is equalized using two or more detected pilot symbols PL, and the channel estimate to each subcarrier is calculated.

[0052] The channel estimate for every subcarrier for which it asked is supplied to the subcarrier composition channel presumption section 9, it compounds by equalization, linear interpolation processing, etc. over all subcarriers, and the channel estimate of subcarrier composition is calculated. Here, the equalized example is shown. The complex-conjugate value and the back-diffusion-of-electrons means 31P and 31C of this channel estimate; -- They are Multipliers 111P and 111C about the data from;3MP and 3MC.; -- By;11MP and 11MC, multiplication is carried out and phasing phase fluctuation of each information symbol is compensated, respectively. The signal after phase fluctuation compensation is supplied to the parallel serial conversion machine 13, and it changes into serial data. This serial data is supplied to the RAKE composition section 15 with the signal from other RAKE fingers, and inphase composition is carried out.

[0053] In drawing 13 , the conversion means 1, such as FFT and DFT, decompose a received-data sequence into the component to each subcarriers SC1, --, SCM. Here, the example which used FFT is shown. They are the back-diffusion-of-electrons means 31P and 31C about the sequence for every decomposed subcarrier.; -- The communication channel CH 1x1 to restore with community pilot channel CH1P, --, CHMP in the subcarrier which supplies;3MP and 3MC and is contained in each sequence here, --, CHMxM Using the diffusion sign replica according to the receiving timing of each multi-pass, the back diffusion of electrons is carried out and it takes out. The receiving channel in sequence CH1P of the common [in a subcarrier] pilot channel by which the back diffusion of electrons was carried out, --, two or more pilot symbols PL that input CHMP into each subcarrier channel presumption sections 71, --, 7M, respectively, and are contained in each subcarriers SC1, --, SCM is equalized, and the channel estimate to each subcarrier is calculated. The channel estimate to each subcarrier for which it asked is supplied to the subcarrier composition channel presumption section 9, it compounds by equalization, linear interpolation processing, etc. over all subcarriers, and the channel estimate of subcarrier composition is calculated. Here, the equalized example is shown. The complex-conjugate value and the back-diffusion-of-electrons means 31P and 31C of this channel estimate; -- They are Multipliers 111P and 111C about the data from;3MP and 3MC.; -- By;11MP and 11MC, multiplication is carried out and phasing phase fluctuation of each information symbol is compensated, respectively. The signal after phase fluctuation compensation is supplied to the parallel serial conversion machine 13, and it changes into serial data. This serial data is supplied to the RAKE composition section 15 with the signal from other RAKE fingers, and inphase composition is carried out.

[0054] Drawing 14 and drawing 15 show the multi-carrier / DS-CDMA demodulator of this invention corresponding to claims 11 and 12, respectively. Drawing 15 which shows the demodulator using a channel configuration (refer to drawing 6) as shows drawing 14 to claim 3 shows the demodulator at the time of using a channel configuration (referring to drawing 9) as shown in claim 6.

[0055] In drawing 14 , the conversion means 1, such as FFT and DFT, decompose a received-data sequence into the component to each subcarriers SC1, --, SCM. The communication channel CH 1x1 to restore in each subcarrier with k common control channel CCHs (drawing 14 k= 1) to all subcarriers out of the sequence for every decomposed subcarrier, --, CHMxM Using the diffusion sign replica according to the receiving timing of each multi-pass, the back diffusion of electrons is carried out and it takes out.

Here, the case of k= 1 is shown. A pilot detecting element supplies k control channel CCHs, detects the location of the pilot symbol PL contained in k control channel CCHs common to all the subcarriers after the back diffusion of electrons here, and takes out a pilot symbol. Two or more detected pilot symbols PL are compounded, the channel presumption section 7 is supplied, and the channel estimate about two or more pilot symbols is calculated. The complex-conjugate value of this channel estimate, data CCH and CH11, --, CH1N1 ; --;CHM1, --, CHMNM Multiplication is carried out with Multipliers 110, 111, 112, --, 11M, and phasing phase fluctuation of each information symbol is compensated. The signal after phase fluctuation compensation is supplied to the parallel serial conversion machine 13, and it changes into serial data. This serial data is supplied to the RAKE composition section 15 with the signal from other RAKE fingers, and inphase composition is carried out.

[0056] In drawing 15 , the conversion means 1, such as FFT and DFT, decompose a received-data sequence into the component to each subcarriers SC1, --, SCM. The communication channel CH 1x1 to restore in k common pilot channels (drawing 15 k= 1) CHP and each subcarriers to all subcarriers out of the sequence for every decomposed subcarrier, --, CHMxM Using the diffusion sign replica according to the receiving timing of each multi-pass, the back diffusion of electrons is carried out and it takes out. Here, the case of k= 1 is shown. The sequence of k pilot channels CHP common to all subcarriers by which the back diffusion of electrons was carried out is inputted into the channel presumption section 7, two or more [here] pilot symbols are compounded, and the channel estimate about two or more pilot symbols is calculated. The complex-conjugate value and Data CHP and CH 1x1 of this channel estimate, --, CHMxM Multiplication is carried out with Multipliers 110, 111, 112, --, 11M, and phasing phase fluctuation of each information symbol is compensated. The signal after phase fluctuation compensation is supplied to the parallel serial conversion machine 13, and it changes into serial data. This serial data is supplied to the RAKE composition section 15 with the signal from other RAKE fingers, and inphase composition is carried out.

[0057]

[Embodiment of the Invention] The example 1 of the multi-carrier / DS-CDMA channel presumption by example 1 this invention is shown in drawing 16 . Drawing 16 is an example which performs the multi-carrier / DS-CDMA channel presumption corresponding to claim 7 using the channel configuration of claim 1. Here, it equalizes in the subcarrier composition channel presumption section 9.

[0058] The sequence of each subcarriers SC1, --, SCM shown in drawing 16 corresponds to the output obtained by performing the back diffusion of electrons in drawing 10 . Drawing 16 is Np contained in each subcarrier. The case where the pilot symbol PL for a symbol is contained to the same timing is shown.

[0059] At the same timing as the sequence after the back diffusion of electrons [as opposed to each subcarrier by the pilot detecting element 5], it is Np. The location of the pilot symbol PL contained by the symbol is detected, and it is Np. The pilot symbol PL for a symbol is inputted into each subcarrier channel presumption sections 71, --, 7M. The receiving channel in Np symbol is equalized by each subcarrier channel presumption sections 71, --, 7M, and the channel estimate to each subcarrier is calculated. The channel estimate (M pieces) about each called-for subcarrier is inputted into the subcarrier composition channel presumption section 9, M piece channel estimate is equalized over all subcarriers, and the channel estimate of a subcarrier average is calculated. Using the channel estimate of the called-for subcarrier average, as shown in drawing 10 , phasing phase fluctuation of the information sequence for the Nd xM symbol to all subcarriers is compensated.

[0060] The example 2 of the multi-carrier / DS-CDMA channel presumption by example 2 this invention is shown in drawing 17 . Drawing 17 is an example which performs the multi-carrier / DS-CDMA channel presumption corresponding to claim 7 using the channel configuration of claim 1. Here, it equalizes in the subcarrier composition channel presumption section 9.

[0061] The sequence of each subcarriers SC1, --, SCM shown in drawing 17 corresponds to the output obtained by performing the back diffusion of electrons in drawing 10 . Drawing 17 is Np contained in each subcarrier. The case where it is contained to the timing from which the pilot symbol PL differs is shown.

[0062] It is Np, respectively at the timing which changed for the sequence after the back diffusion of electrons to each subcarrier with pilot detecting elements 5 since the locations of the pilot symbol contained in each subcarrier differed in the example 2. The timing of the symbol ** rare ** pilot symbol PL is detected. The detected timing is used and it is Np about each subcarrier. The pilot symbol PL for a symbol is detected and it inputs into each subcarrier channel presumption sections 71, --, 7M. It is Np by each subcarrier channel presumption sections 71, --, 7M. The receiving channel in a symbol is equalized and the channel estimate to each subcarrier is calculated. The following procedures are the same as that of an example 1.

[0063] The example 3 of the multi-carrier / DS-CDMA channel presumption by example 3 this invention is shown in drawing 18 . Drawing 18 is an example which performs the multi-carrier / DS-CDMA channel presumption corresponding to claim 8 using the channel configuration of claim 4. Here, it equalizes in the subcarrier composition channel presumption section 9.

[0064] The sequence of each subcarriers SC1, --, SCM shown in drawing 18 corresponds to the output obtained by performing the back diffusion of electrons in drawing 11 .

[0065] The sequence after the back diffusion of electrons of the pilot channel to each subcarrier is inputted into each subcarrier channel presumption sections 71, --, 7M. In each subcarrier channel presumption section, the receiving channel in N symbol is equalized by 71, --, 7M, and the channel estimate to each subcarrier is calculated. The channel estimate (M pieces) about each called-for subcarrier is inputted into the subcarrier composition channel presumption section 9, the channel estimate of M pieces is equalized over all subcarriers, and the channel estimate of a total subcarrier average is calculated. Using the channel estimate of the called-for total subcarrier average, as shown in drawing 11 , phasing phase fluctuation of the information sequence for the NxM symbol to all subcarriers is compensated.

[0066] The example 4 of the multi-carrier / DS-CDMA channel presumption by example 4 this invention is shown in drawing 19 . Drawing 19 is an example which performs the multi-carrier / DS-CDMA channel presumption corresponding to claim 9 using the channel configuration of claim 2. Here, it equalizes in the subcarrier composition channel presumption section 9.

[0067] The sequence of each subcarriers SC1, --, SCM shown in drawing 19 corresponds to the output obtained by performing the back diffusion of electrons in drawing 12 .

[0068] Common control channel CCH1 in a subcarrier and --, and Np contained in the sequence after the back diffusion of electrons of CCHM The location of the pilot symbol PL for a symbol is detected. [as opposed to each subcarrier by the pilot detecting element 5] Np [as opposed to each subcarrier using the detected timing] The pilot symbol PL for a symbol is detected and it inputs into each subcarrier channel presumption sections 71, --, 7M. It is Np by each subcarrier channel presumption sections 71, --, 7M. The receiving channel in a symbol is equalized and the channel estimate to each subcarrier is calculated. Input the channel estimate (M pieces) about each called-for subcarrier into the subcarrier composition channel presumption section 9, and the channel estimate of M pieces is equalized over all subcarriers. Using the channel estimate of the called-for total subcarrier average which calculates the channel estimate of a total subcarrier average, as shown in drawing 12 Common control channel CCH1 in a subcarrier about each subcarrier, --, Nd contained in CCHM Phasing phase fluctuation with the information sequence of a symbol and the information sequence included in the communication channel in each subcarrier is compensated.

[0069] The example 5 of the multi-carrier / DS-CDMA channel presumption by example 5 this invention is shown in drawing 20 . Drawing 20 is an example which performs the multi-carrier / DS-CDMA channel presumption corresponding to claim 10 using the channel configuration of claim 5. It equalizes in the subcarrier composition channel presumption section 9 here.

[0070] The sequence of each subcarriers SC1, --, SCM shown in drawing 20 corresponds to the output obtained by performing the back diffusion of electrons in drawing 13 .

[0071] The sequence after community pilot channel CH1P, --, the back diffusion of electrons of CHMP is inputted into each subcarrier channel presumption sections 71, --, 7M in the subcarrier to each subcarrier. The receiving channel in community pilot channel CH1P, --, N symbol contained in CHMP

is equalized in the subcarrier about each subcarrier by each subcarrier channel presumption sections 71, --, 7M, and the channel estimate to each subcarrier is calculated. The channel estimate (M pieces) about each called-for subcarrier is inputted into the subcarrier composition channel presumption section 9, the channel estimate of M pieces is equalized over all subcarriers, and the channel estimate of a total subcarrier average is calculated. Using the channel estimate of the called-for total subcarrier average, as shown in drawing 13 R> 3, phasing phase fluctuation of the information sequence included in the communication channel of all subcarriers is compensated.

[0072] The example 6 of the multi-carrier / DS-CDMA channel presumption by example 6 this invention is shown in drawing 21 . Drawing 21 is an example which performs the multi-carrier / DS-CDMA channel presumption corresponding to claim 11 using the channel configuration of claim 3. Here, it equalizes in the subcarrier composition channel presumption section 9.

[0073] The sequence for every [SC1, --, SCM] subcarrier shown in drawing 21 corresponds to the output obtained by performing the back diffusion of electrons in drawing 14 .

[0074] Np contained in the sequence after the back diffusion of electrons of common control channel CCH by the pilot detecting element 5 to all subcarriers The location of the pilot symbol for a symbol is detected. The detected timing is used and it is Np. The pilot symbol PL for a symbol is detected and it inputs into the channel presumption section 7. It is Np by the channel presumption section 7. The receiving channel in a symbol is equalized and channel estimate is calculated. Nd contained in common control channel CCH to all subcarriers using the calculated channel estimate as shown in drawing 14 Phasing phase fluctuation with the information sequence of a symbol and the information sequence included in the communication channel of all subcarriers is compensated.

[0075] The example 7 of the multi-carrier / DS-CDMA channel presumption by example 7 this invention is shown in drawing 22 . Drawing 22 is an example which performs the multi-carrier / DS-CDMA channel presumption corresponding to claim 12 using the channel configuration of claim 6. Here, it equalizes in the subcarrier composition channel presumption section 9.

[0076] The sequence of each subcarriers SC1, --, SCM shown in drawing 22 corresponds to the output obtained by performing the back-diffusion-of-electrons back in drawing 15 .

[0077] The sequence after the back diffusion of electrons of the common pilot channel CHP is inputted into the channel presumption section 7 to all subcarriers. The receiving channel in the pilot symbol contained in a common pilot channel by the channel presumption section 7 to a **** subcarrier is equalized, and channel estimate is calculated.

[0078] Using the calculated channel estimate, as shown in drawing 15 R> 5, phasing phase fluctuation of the information sequence included in the communication channel of all subcarriers is compensated.

[0079]

[Effect of the Invention] Since it was made to make equal transmission-line fluctuation in each subcarrier by equalizing the pilot symbol of all subcarriers according to this invention, fluctuation of a transmission line can be presumed more to high degree of accuracy, and the multi-carrier / DS-CDMA channel presumption which compensates the fluctuation can be performed.

[0080] If an information transmission rate becomes a high speed and correlation of the transmission-line fluctuation between each subcarrier becomes small by the conventional multi-carrier method, by this invention, the insertion approach of a pilot symbol will not be limited to having had to insert many pilot symbols for every subcarrier. And in this invention, since all the inserted pilot symbols can be used for channel presumption and compensation of all subcarriers, channel presumption and compensation are efficiently realizable for high degree of accuracy more.

[Translation done.]